Claims:

1. A method of processing a digital image, comprising the steps of:

providing digital data indexed to represent positions of an image having S spectral bands for simultaneous output on a display, said digital data being indicative of an intensity value $I_i(x,y)$ for each position (x,y) in each i-th spectral band;

defining a classification of said image based on dynamic range of said image in each of said S spectral bands;

adjusting said intensity value for said each position in each i-th spectral band to generate an adjusted intensity value for said each position in each i-th spectral band in accordance with

$$\sum_{n=1}^{N} W_n \left(\log I_i(x,y) - \log[I_i(x,y) * F_n(x,y)]\right),\ i=1,\ldots,S$$

where S is the number of unique spectral bands included in said digital data and, for each n, W_n is a weighting factor and $F_n(x,y)$ is a unique surround function applied to said each position (x,y) and N is the total number of unique surround functions; and

filtering said adjusted intensity value for said each position of said image in each of said S spectral bands using a filter function based on said classification of said image wherein a filtered intensity value $R_i(x,y)$ is defined.

2. A method according to claim 1 wherein each said unique surround function is a Gaussian function.

3. A method according to claim 2 wherein said Gaussian function is of the form

$$e^{\frac{-r^2}{c_n^2}}$$

satisfying the relationship

$$k_n \iint e^{\frac{-r^2}{c_n^2}}\, dxdy = 1$$

where

$$r = \sqrt{x^2+y^2}$$

and, for each n, k_n is a normalization constant and c_n is a unique constant for each of said N unique surround functions.

4. A method according to claim 1 further comprising the step of multiplying said filtered intensity value $R_i(x,y)$ by

$$\log\left[\frac{BI_i(x,y)}{\sum_{i=1}^{S} I_i(x,y)}\right]$$

to define a color-restored intensity value $R'_i(x,y)$, where B is a constant.

5. A method according to claim 1 wherein said each position (x,y) defines a pixel of said display.

6. A method according to claim 1 wherein, for each n, $W_n=1/N$.

7. A method according to claim 1 wherein said step of defining comprises the step of using image statistics associated with said image in each of said S spectral bands to select said filter function.

8. A method according to claim 7 wherein said image statistics include brightness and contrast of said image in each of said S spectral bands.

9. A method according to claim 1 further comprising the steps of:

selecting a maximum intensity value $V_i(x,y)$ from the group consisting of said intensity value $I_i(x,y)$ and said filtered intensity value $R_i(x,y)$; and

displaying an improved image using said maximum intensity value $V_i(x,y)$.

10. A method according to claim 4 further comprising the steps of:

selecting a maximum intensity value $V_i(x,y)$ from the group consisting of said intensity value $I_i(x,y)$ and said color-restored intensity value $R'_i(x,y)$; and

displaying an improved image using said maximum intensity value $V_i(x,y)$.

11. A method of processing a digital image, comprising the steps of:

providing digital data indexed to represent the positions of a plurality of pixels of a J-row by K-column display, said digital data being indicative of an intensity value I(x,y) for each of said plurality of pixels where x is an index of a position in the J-th row of said display and y is an index of a position in the K-th column of said display wherein a JxK image is defined;

convolving said digital data associated with each of said plurality of pixels with a function

$$e^{\frac{-r^2}{c^2}}$$

to form a discrete convolution value for each of said plurality of pixels, said function satisfying the relationship

$$k\iint e^{\frac{-r^2}{c^2}}\,dxdy = 1$$

where

$$r = \sqrt{x^2+y^2}$$

k is a normalization constant and c is a constant;

converting, for each of said plurality of pixels, said discrete convolution value into the logarithm domain;

converting, for each of said plurality of pixels, said intensity value into the logarithm domain;

subtracting, for each of said plurality of pixels, said discrete convolution value so-converted into the logarithm domain from said intensity value so-converted into the logarithm domain, wherein an adjusted intensity value is generated for each of said plurality of pixels; and

filtering said adjusted intensity value for each of said plurality of pixels with a filter function that is based on dynamic range of said JxK image wherein a filtered intensity value R(x,y) is defined.

12. A method according to claim 11 wherein the value of said constant c is selected to be in the range of approximately 0.01 to approximately 0.5 of the larger of J and K.

13. A method according to claim 11 further comprising the steps of:

selecting, for each of said plurality of pixels, a maximum intensity value V(x,y) from the group consisting of said intensity value I(x,y) and said filtered intensity value R(x,y); and

displaying an improved image using said maximum intensity value V(x,y).

14. A method of processing a digital image, comprising the steps of:

providing digital data indexed to represent the positions of a plurality of pixels of an J-row by K-column display, said digital data being indicative of an intensity value $I_i(x,y)$ for each i-th spectral band of S spectral bands for each of said plurality of pixels where x is an index of a position in the J-th row of said display and y is an index of a position in the K-th column of said display wherein a $(JxK)_i$ image is defined for each of said S spectral bands and a JxK image is defined across all of said S spectral bands;

defining a classification of said JxK image based on dynamic range of each said $(JxK)_i$;

convolving said digital data associated with each of said plurality of pixels in each i-th spectral band with a function

$$e^{\frac{-r^2}{c_n^2}}$$

for n=2 to N to form N convolution values for each of said plurality of pixels in each said i-th spectral band, said function satisfying the relationship

$$k_n \int\int e^{\frac{-r^2}{c_n^2}} dxdy = 1$$

where

$$r = \sqrt{x^2+y^2}$$

and, for each n, k_n is a normalization constant and c_n is a

unique constant;

converting, for each of said plurality of pixels in each said i-th spectral band, each of said N convolution values into the logarithm domain;

converting, for each of said plurality of pixels in each said i-th spectral band, said intensity value into the logarithm domain;

subtracting, for each of said plurality of pixels in each said i-th spectral band, each of said N convolution values so-converted into the logarithm domain from said intensity value so-converted into the logarithm domain, wherein an adjusted intensity value is generated for each of said plurality of pixels in each said i-th spectral band based on each of said N convolution values;

forming a weighted sum for each of said plurality of pixels in each said i-th spectral band using said adjusted intensity values; and

filtering said weighted sum for each of said plurality of pixels in each said i-th spectral band with a filter function that is based on said classification of said JxK image wherein a filtered intensity value $R_i(x,y)$ is defined.

15. A method according to claim 14 wherein the value for each said unique constant c_n is selected to be in the range of approximately 0.01 to approximately 0.5 of the larger of J and K.

16. A method according to claim 14 further comprising the step of multiplying said filtered intensity value $R_i(x,y)$ by

$$\log\left[\frac{BI_i(x,y)}{\sum_{i=1}^{S} I_i(x,y)}\right]$$

to define a color-restored intensity value $R'_i(x,y)$, where B is a constant and S is a whole number greater than or equal to 2.

17. A method according to claim 14 wherein said step of defining comprises the step of using image statistics associated with each said $(JxK)_i$ image to select said filter function.

18. A method according to claim 17 wherein said image statistics include brightness and contrast of each said $(JxK)_i$ image.

19. A method according to claim 14 further comprising the steps of:

selecting a maximum intensity value $V_i(x,y)$ from the group consisting of said intensity value $I_i(x,y)$ and said filtered intensity value $R_i(x,y)$; and

displaying an improved image using said maximum intensity value $V_i(x,y)$.

20. A method according to claim 16 further comprising the steps of:

selecting a maximum intensity value $V_i(x,y)$ from the group consisting of said intensity value $I_i(x,y)$ and said color-restored intensity value $R'_i(x,y)$; and

displaying an improved image using said maximum intensity value $V_i(x,y)$.

21. A method of processing a digital image, comprising the steps of:

providing digital data indexed to represent positions of an image having S spectral bands for simultaneous output on a display, said digital data being indicative of an intensity value $I_i(x,y)$ for each position (x,y) in each i-th spectral band;

defining a classification of said image based on dynamic range of said image in each of said S spectral bands;

adjusting said intensity value for said each position in each i-th spectral band to generate an adjusted intensity value for said each position in each i-th spectral band in accordance with

$$\sum_{n=1}^{N} W_n \ (\log I_i(x,y) - \log[I_i(x,y) * F_n(x,y)]), \ i=1,\ldots,S$$

where S is a whole number greater than or equal to 2 and defines the total number of spectral bands included in said digital data and, for each n, W_n is a weighting factor and $F_n(x,y)$ is a unique surround function of the form

$$e^{\frac{-r^2}{c_n^2}}$$

satisfying the relationship

$$k_n \iint e^{\frac{-r^2}{c_n^2}} \, dxdy = 1$$

where

$$r = \sqrt{x^2+y^2}$$

and, for each n, k_n is a normalization constant and c_n is a unique constant where N is the total number of unique surround functions;

filtering said adjusted intensity value for said each position in each i-th spectral band with a function based on said classification of said image wherein a filtered intensity value $R_i(x,y)$ is defined; and

multiplying said filtered intensity value $R_i(x,y)$ by

$$\log\left[\frac{BI_i(x,y)}{\sum_{i=1}^{S} I_i(x,y)}\right]$$

to define a color-restored intensity value $R'_i(x,y)$, where B is a constant.

22. A method according to claim 21 wherein, for each n, $W_n=1/N$.

23. A method according to claim 21 wherein the value for each said unique constant c_n is selected to be in the range of approximately 0.01 to approximately 0.5 of the larger of J and K.

24. A method according to claim 21 wherein said step of defining comprises the step of using image statistics associated with said image in each of said S spectral bands to select said filter function.

25. A method according to claim 24 wherein said image statistics include brightness and contrast of said image in each of said S spectral bands.

26. A method according to claim 21 further comprising the steps of:

selecting a maximum intensity value $V_i(x,y)$ from the group consisting of said intensity value $I_i(x,y)$ and said color-restored intensity value $R'_i(x,y)$; and

displaying an improved image using said maximum intensity value $V_i(x,y)$.